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PERFORMANCE COMPARISON BETWEEN GENETIC ALGORITHM AND ANT COLONY OPTIMIZATION ALGORITHM FOR MOBILE ROBOT PATH PLANNING IN GLOBAL STATIC ENVIRONMENT

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Candidate's Declaration

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as reference work. This topic has not been submitted to any other academic institution or non-academic institution for any other degree or qualification.

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ABSTRACT

Path planning (PP) together with mapping and localization are important elements in autonomous mobile robot navigation systems. In both global and local PP systems, a mobile robot should be able to navigate effectively until it reaches a destination without colliding with any obstacles within an environment. Due to the importance of global path planning in mobile robot navigation systems, the research presented herewith focused on the optimization problem of path planning for mobile robots. The problem is to find the global path that satisfies the optimization criteria, which are shorter path length and less computation time. This will lead to the reduction of the energy consumption of the robot itself. The main goal of this research is to compare the performances between Genetic Algorithm (GA) and Ant Colony Optimization (ACO) algorithm. The objective is to verify and compare the effectiveness of both algorithms in finding the optimal robot path in different types of global map environments. The selected environments consist of different complexities of feasible nodes and different complexities of obstacles. In the initial stage, the test environments were constructed. Subsequently, both algorithms were applied to the test environments. Finally, the performances of both algorithms were analyzed and evaluated based on the required criteria. The results of the research indicated that ACO was more robust compared to GA as it was capable of finding the optimal path in all the tested environments. In addition, parameter settings of ACO required for each case were very straightforward compared to GA. The robustness of ACO to determine an optimal path was proven in this research. This indicates that ACO optimization technique has great potential for solving other optimization problems.

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Shah Alam

CHAPTER 1

INTRODUCTION

1.0 Introduction

Autonomous mobile robot navigation research attracts a great interest among researchers to solve the mapping, localization, control and path planning (PP) problems of the robot itself [1, 2]. The problem of finding a safe path to goal position without colliding with obstacles within the environment is known as robot PP problem. With an effective PP system, an autonomous mobile robot should be able to navigate effectively within its environment without any guidance and intervention from a human. Due to the importance of robot PP in enhancing a robot's navigation system, the areas of research related to PP have expanded tremendously since 1980 [2-4].

In general, robot PP can be divided into two categories, which is global [5, 6] and local PP [7-10]. By having the knowledge of the global environment or the global map of the robot workspace area, this global optimal path can be planned offline. This can be achieved by modeling the map and applying an appropriate PP algorithm throughout the system as implemented by previous researchers such as Nagib et al [11], Gengqian et al [2], and Warren [6]. With the global path, the process of finding a path to goal position while traversing the real environment has been simplified. Local PP also plays an important role in creating a path when a robot faces dynamic obstacles. As the robot avoids the obstacles, a local path will be constructed by using an appropriate algorithm. Therefore, global and local PP complement each other [12-14] and the utilization of both PP approaches depend on the applications and objectives of the research itself. For example, to solve PP problems in dynamic environments, Mei et al [12] had applied the global PP approach, known as Ant Colony Optimization (ACO) algorithm with a local PP, known as Artificial Potential